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Residual Nutrient Removal by a Winter Cover Crop From Broiler Litter Amended Soils

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RESIDUAL NUTRIENT REMOVAL BY A WINTER COVER
CROP FROM BROILER LITTER AMENDED SOILS

A Thesis

Presented to

The Faculty of the Department of Agriculture

Western Kentucky University

Bowling Green, Kentucky

In Partial Fulfillment

Of the Requirements for the Degree

Master of Science

By

Jennifer Michelle Johnson

May 2007

RESIDUAL NUTRIENT REMOVAL BY A WINTER COVER

CROP FROM BROILER LITTER AMENDED SOILS

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DEDICATION

To my parents, Kenneth and Karen Johnson, who have always taught me that I can do anything I put my mind to, no matter how hard, and once I start something I must see it through to the finish. If not for their encouraging words of wisdom and exposure to the agriculture lifestyle, I would not be where I am today. Continually they will be my inspiration to further my career in this field.

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RESIDUAL NUTRIENT REMOVAL BY A WINTER COVER
CROP FROM BROILER LITTER AMENDED SOILS

Jennifer Johnson

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32 Pages

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Poultry production throughout Southern Kentucky is becoming a major agricultural enterprise. Rapid spread of the industry has led to many agricultural advances as well as concerns. One primary concerns is the possible nutrient build-up in pasture and cropland as a result of broiler litter application. Studies were conducted at Western Kentucky University using sorghum sudangrass (*Sorghum bicolor* (L.) Moench) as a forage to possibly remove excess nutrients. This project led to a consideration of using a cover crop to further remove nutrients from broiler litter amended soils.

This study's objective was to assess total nutrient removal by sorghum sudangrass followed by a rye (*Secale cereale* L.) cover crop compared to single crop of sorghum sudangrass as a tool for preventing excess soil nutrient accumulation. A randomized complete block experiment was established in 2005 with four replications and four treatments was conducted: litter applied at recommended nitrogen [Litter-N] rate; litter applied at the recommended P rate with commercial nitrogen [Litter-P+N]; litter applied at the recommended P rate [Litter-P]; and soil amended with inorganic fertilizer

[INORG]. Sorghum sudangrass was seeded in the spring and rye planted after the last harvest of the season. Forage acid detergent fiber (ADF), neutral detergent fiber (NDF), crude protein (CP), P, Cu, Fe, and Zn were determined, as well as soil nutrient levels. After analyzing the data from one year, 2005, it was determined that, although differences were noted, the rye cover crop did not mitigate available soil P, Cu, and Zn.

CHAPTER I

INTRODUCTION

The United States poultry (*Gallus gallus*) industry has seen rapid growth during the past several years. As the number of birds increased throughout Kentucky, so has the amount of broiler litter produced. Studies have shown that in 1990 there were approximately 64 broiler houses throughout the state of Kentucky; in 2005 there were greater than 12,600 houses (6). It has been estimated that each house has the potential to produce from 127 to 137 metric tons (140 to 150 tons) total litter per year (11). Considering these numbers, it can be estimated that in 1990 there were only 8709 metric tons (9600 tons) of litter produced as compared to 2005 when there were approximately 1,724,390 metric tons (1.9 mill. tons) of litter produced in Kentucky; an increase of nearly 200 fold in a 15 year span (6).

With the rapid growth in the poultry industry and subsequent increase in broiler litter production, methods of litter disposal are required. Using broiler litter as a fertilizer source is a best management practice farmers have begun to utilize throughout the state. Broiler litter contains a high nutrient content, making it one of the highest valued manures available at this time. One study showed that after five flocks, broiler litter contained an average of 25.4 kg (56 lbs) of nitrogen (N), 29.5 kg (65 lbs) of phosphate (P_2O_5), and 28.6 kg (63 lbs) of potash (K_2O) per ton of litter, as well as many secondary and micronutrients. Many factors can contribute to differences in broiler litter nutrient

content; therefore analysis near the time of application is needed to determine available nutrient content of the litter (11).

Broiler litter has been reported as an excellent fertilizer source in cropping systems, as well as on pastures and in hay fields. However, when observing soil sample reports, annual application of litter has been shown to cause rapid accumulation of certain soil nutrients, especially P, Cu, and Zn (11). As nutrient build-up occurs, measures need to be taken to prevent and/or correct this build-up. The objective of this research was to assess total nutrient removal by sorghum-sudangrass (*Sorghum bicolor* (L.) Moench) followed by a cereal rye (*Secale cereale*) cover crop compared to a single crop of sorghum-sudangrass.

CHAPTER II

LITERATURE REVIEW

Broiler Litter

As the broiler industry continues to expand so does the amount of broiler litter produced. Broiler litter includes, but is not limited to, a mixture of manure, wasted feed, feathers and wood shavings or other crop residue (1). All of these components can contribute to the amount of nutrients found in broiler litter that may be used for fertilizer application. As demand and cost increases for commercial fertilizer, use of broiler litter and other alternative fertilizer sources also increases.

Numerous studies have reported that water quality problems can be caused by phosphorous (P) entering surface water in runoff (3). According to Rasnake (14), “when P is applied repeatedly in excess of that removed from harvested crops, soil test P can increase to a level that becomes a concern for water quality.” Moreover arsenic (As), cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), selenium (Se), and zinc (Zn) are heavy metals that are added to poultry diets and if applied to the soil through broiler litter can also enter the surface water through runoff and leaching thus leading to contamination (5). However, if nutrients are applied at rates comparable to crop utilization rates and extracted in a harvested crop they will not contribute to possible pollution at that location (15).

The aforementioned problems highlight the importance and need to develop best management practices for handling, storing, and utilizing broiler litter in an environmentally sustainable manner.

Agronomic Uses of Animal Manure

There are many uses of broiler litter in the agriculture industry. Most prevalent has been the use of litter as a fertilizer source for crop production. It has been determined that there exists considerable agronomic value to animal manures, depending on nutrient and organic matter content. Animal manure nutrient content is closely related to the chemical composition of animal feeds. Although some nutrients are lost through the digestive process many still remain in the by-products excreted from the animal. According to a recent University of Kentucky publication approximately 75% of nitrogen, 80% of phosphorus, and 85% of potassium consumed by cattle are excreted through urine and feces (14). When considering other livestock manures, reports show that poultry and swine feeds contain greater amounts of heavy metals than do cattle feeds. Copper and Zinc are two heavy metals that have been shown to accumulate in soils treated with animal wastes. Poultry utilization of these heavy metals have been reportedly low, suggesting that only 6% of Zn is retained within the broiler. Thus many broiler litter applications lead to heavy metal accumulation in the soil due to the excess of nutrients and low plant requirements (10).

Nutrient uptake of plants is closely related to that excreted in the feces of grazing animals; therefore by allowing for grazing and redeposit of manure on amended soils, build-up occurs. Reduction of build-up is directly related to removal of harvested forage from the location (10). When applying manures for fertilizer, the nutrient content of the

manure as well as the needs of the plant and nutrients already available in the soil must be known (13). If the application of litter is based on the plant N requirements, it could lead to P build-up in the soil. Using N based applications is directly related to an excess of many soil nutrients, such as Cu, Zn, and P (10).

Broiler Litter in the Soil

Use of broiler litter as a fertilizer in cropping and forage systems can adversely affects soil nutrient content, can lead to build-up, and influence soil organic matter content (SOM). One study utilizing cotton with a winter rye cover crop reported that an increase in SOM resulted from large amounts of crop and litter residues. The study reported plots amended with 100 kg N ha^{-1} poultry litter resulted in 21% and 35% higher SOM than plots receiving the same amount of inorganic N; similar results occurred on plots that received 200 kg N ha^{-1} of poultry litter versus plots with equivalent ammonium nitrate at a rate of 55% and 80% higher SOM. The same study reported a 46% higher extractable P concentration in the more heavily fertilized plots during the final year of the study. Original soil tests showed normal levels and P utilization of the cotton and rye (*Secale cereale*) cover crop. Therefore, the study suggests, on a short-term basis P was utilized and build-up was controlled through the plants. However, on a long-term basis they were unable to maintain successful P-uptake and utilization, thus leading to build-up. Under a similar fertilizer regime, a management practice that included use of a main in-season crop, cotton (*Gossypium hirsutum* L.), followed by a winter cover crop of rye helped prevent significant nutrient build-up compared to a system with just the main crop (9).

When maintaining sustainable production, producers should consider whether or not soil nutrients are deficient or excessive. Producers must maintain an understanding of the manure to soil nutrient dynamics and keep a well-managed system in order to control nutrient build-up (18). Many producers spread broiler litter based exclusively on N requirements, rather than focusing on P requirements. When applying based on N requirements producers can easily mismanage the amount of nutrients in the manure compared to those in the soil; thus allowing for possible P build-up. Without proper utilization, mismanagement will always occur due to N/P manure ratios being lower than N/P crop requirements (7).

Amount of available soil P fluctuates over time and can be altered due to a number of soil characteristics such as soil texture and organic matter as well as the plants P uptake abilities. It is widely known that not all added P is completely available to the plant for uptake. Producers must also be aware that there is a distinct difference between manure-P availability and mineral-P fertilizer availability. Experiments showed that over time all extractable soil P changed and there were significant differences caused by P source. Water-soluble P became in essence immediately available to plants and allowed for quick uptake. Mineral P fertilizer sources were completely soluble in water, whereas manure P sources were not. Three soils were utilized at low, medium, and high soil P levels with differing P saturation rates. Once amended with P solution it was determined that both the low and medium P soils had a greater capacity for P adsorption and resulted in increased P concentrations compared to high P soils, with the low performing better than the medium. Medium P soils had a lower capacity to adsorb than did the low P soil.

The high P level soil resulted in desorption. As expected, in all cases increases in extractable soil P resulted in lower P adsorption (4).

Broiler Litter and Forages

There are many common forages used for pasture and hay production throughout the southeastern United States. Producers have begun to use broiler litter and other manure products as fertilizer sources for these areas instead of commercial fertilizers. Annual ryegrass (*Lolium multiflorum*) and warm-season crabgrass (*Digitaria ciliaris*) are two of these common grasses used to provide year-round pasture and hay for livestock production systems. Although considered a weed in many farming situations, warm-season crabgrass has several positive aspects making it one of the more desirable grasses in a mixed year-round green pasture with broiler litter enriched soils. Reports have indicated that crabgrass is very effective at removing P from the soil. Phosphorous build-up due to long-term litter applications has caused alarm; therefore many producers are looking for alternative grasses for pasture use. Tall fescue (*Festuca arundinacea*) and orchardgrass (*Dactylis glomerata*) are other forage grasses that have been used to remove N and P. Forages with a strong capability of removing residual nutrients from the soil in broiler litter enriched areas are preferred (17).

Annual ryegrass is considered to be the most commonly used winter annual forage in the Southern region of the United States. Annual ryegrass performs well when compared to other forages in broiler litter fertilized fields. Annual ryegrass is reportedly as effective as other forages in nutrient uptake, specifically N, P, K, Cu, and Zn uptake, and performs exceptionally well in whole-plant nutrient uptake as compared to other forages. As in any forage system it must be remembered that when using broiler litter as

a fertilizer source over a long period of time, build-up will occur. Therefore the most effective method for removing excessive nutrients from these enriched pasture areas is in hay production and off-farm sale. While other harvesting methods are acceptable (silage, green chop and baleage), they present more difficulty in transportation away from the local area. Residual nutrient removal is directly based on removable yield (10).

Winter Cover Crops

Cover crops are those crops, either grasses or legumes, that are grown to protect and improve soil when it would otherwise be bare or in a non-productive state (8). Cover crops not only cover the ground but also aid in prevention of N and other nutrient leaching and soil erosion (19). These are chosen based on their ability to provide beneficial results when controlling erosion, improving soil quality, capturing nutrients, and conserving water (2). There are many options for cover crops, but winter small grains or grasses seem to be most commonly used due to their rapid growth, winter hardiness, and easily available seed. Some of the more common winter cover crops are wheat (*Triticum aestivum*), rye, barley (*Hordeum vulgare*), triticale (*Triticum secale*), annual ryegrass and hairy vetch (*Vicia villosa*) (19). According to Rowe (15) “A recognized best management practice in the South is the use of the winter cover crops for control of soil surface erosion but recent research by Brink et al. (1) indicated the added benefit of harvesting the cover crop is to extract 10 to 25% more P than would be harvested just in the summer.” The Southern U.S. uses winter cover crops for many of the same reasons including capturing nutrients that might be leached or lost. Although many producers choose grasses over legumes, it has been determined that some legumes may be excellent cover crops. If established correctly, a clover cover crop has the potential of

removing 25% more P, 40% more Zn and 72% more Cu than many grasses while also producing a more valuable hay crop (15).

Cereal Rye as a Winter Cover Crop

Winter rye is one of the most commonly used cover crops. It is appealing due to its good ground covering abilities as well as its nitrate absorption from the soil (2). It is one of the easiest crops to grow and responds well to N fertilizer, although in many situations it does not require additional N and often times is called a 'scavenger' for residual N; thus a good crop used for soil nutrient removal (20). Rye is often considered one of the best small grain cover crops to use in Kentucky due to its quick germination, fast growth, good cover, and nutrient uptake abilities from previous crop residue (12). In a study comparing nutrient uptake of 16 forage species, rye performed very well. With annual ryegrass being the most commonly used forage in this region, performance of each species was compared to that of annual ryegrass. Grasses present in the study were annual ryegrass, and three cereals, rye, oats (*Avena sativa*), and wheat. In the study it was determined that rye leaves and flowers contained a greater N concentration than annual ryegrass. Rye stems contained greater P, K concentrations, and also contained greater Cu concentrations. Of the cereals in the study rye was the most effective at nutrient removal, having a performance comparable to that of annual ryegrass (10).

CHAPTER III

MATERIALS AND METHODS

Field experiments were conducted from fall 2005 through summer 2006 at the Agricultural Research and Education Complex of Western Kentucky University, Bowling Green, Kentucky to evaluate the residual nutrient removal by a winter cover crop from broiler litter amended soils. A randomized complete block design was utilized with four treatments and four replications. Treatments were defined as (i) litter applied at recommended nitrogen (N) rate [Litter N], (ii) litter applied at recommended phosphorous (P) rate [Litter-P], (iii) litter applied at recommended P rate with supplemental N [Litter – P + N], and (iv) inorganic fertilizer [INORG].

Sorghum sudangrass plots were established in a prepared seedbed on a Pembroke silt loam (Mollic Paleudalf) with a pH of 5.1. Prior to sorghum sudangrass establishment 20 to 25 soil samples (15 cm depth) were taken from each plot to determine fertility needs. Sixteen plots measured 7.6 m X 30.5 m with 4.6 m alleys were employed. Plots were disked in preparation; lime and fertilizers were applied as recommended based on soil test results and incorporated using a spring tine harrow (Table 1). Fertility requirements were based on crop N and P needs and soil chemical characteristics of each plot. Broiler litter application based on either N or P requirements were determined based on the amount of either N or P in broiler litter and estimated availability.

Table 1. 2005 broiler litter and inorganic fertilizer applications based on a dry weight basis from soil test analysis.

-----Broiler Litter-----	
Treatment	Mg/ha
Litter-N	15.16
Litter-P	0.94
Litter-P + N	0.94
Inorganic	---
-----Inorganic Fertilizer-----	
Treatment	Kg/ha
Litter-N	---
Litter-P	---
Litter-P+N	210 N
Inorganic	225 N
	14.7 P
	35.6 K

Plots were cultipacked, and sorghum sudangrass seed (cv. 'Hayman') was planted using a no-till drill at a planting rate of 40 kg/ha. At the end of growing season, half the plot area was planted to a cover crop of cereal rye to assess the potential nutrient removal by a winter cover crop.

After sorghum sudangrass harvest in September 2005, plots were divided into two sides, A and B respectively. The B plots planted to a winter cover crop of cereal rye (c.v. Frontier Grazer) at 102 kg/ha and A plots were left fallow. Approximately 15 soil samples were taken from each of 32 plots at a depth of 15 cm prior to rye harvest. Cereal rye was harvested April 17, 2006 at the early head stage using a Wintersteiger Hege 212 forage plot harvester with a cutting width of a 150 cm. Plots weights were recorded using the plot harvester. Grab samples were taken, weighed, dried in a forced-air dryer at 60°C for 48 hours, and reweighed. Samples were ground to pass through a 1-mm screen and analyzed using NIR technology. Soil samples were sent for analysis to A&L laboratories in Memphis, TN. Data was analyzed statistically using the General Linear Model procedure of SAS (16).

CHAPTER IV

RESULTS AND DISCUSSION

Broiler litter and inorganic fertilizers were applied to each plot as assigned by a randomized complete block design. Fertilizer amounts applied to each plot were determined by soil test requirements for the entire plot area. Nutrients were applied based on soil test recommended rates and available nutrients in the fertilizers. Table 2 illustrates the soil nutrient levels in 2005 before the initial fertilization.

ADF and NDF were elevated in Litter-N as compared to Litter-P treatments. Litter-P produced lower ADF when compared to Litter-P+N plots, while INORG fertility regimes produced comparable NDF to all regimes. There was no treatment effect on CP (Table 3).

The rye cover crop did uptake significant nutrient concentrations showing treatment by nutrient interactions. Phosphorous, Cu, and Fe uptake were higher in Litter-N plots than in Litter-P plots. Litter-P+N plots and INORG plots were comparable to all treatments as well as each other. Zn concentrations were not influenced by treatment (Table 4).

Available soil P was not influenced by cover crop within treatment, although there was a higher P concentration in Litter-N plots as compared to the other treatments. Although not statistically different, a rye cover crop removed 13% more P from the soil than did plots without a cover crop, across all four treatments (Figure 1).

Table 2. Soil nutrient levels across all plots at beginning of study (pre-plant data).

Nutrient	Soil Concentration
	mg/kg
P	70.7
K	133.6
Ca	1956.9
Mg	112.3
S	14.6
B	0.90
Cu	2.36
Fe	165.0
Mn	233.5
Na	24.7
Zn	4.49

Table 3. Forage quality comparisons of acid detergent fiber (ADF), neutral detergent fiber (NDF), and crude protein (CP) in rye cover crop under varying broiler litter and inorganic fertilizer fertility regimes.

Treatment	-----g kg ⁻¹ DM ⁺ -----		
	ADF	NDF	CP
Litter -N	323a*	618a	111a
Litter-P	310c	601b	95a
Litter-P +N	320ab	617a	101a
INORG	313bc	610ab	97a

*Numbers followed by the same letters within a column do not differ at the 0.05 level of significance.

+Dry Matter

Table 4. Nutrient concentration in a rye cover crop under varying broiler litter and inorganic fertilizer fertility regimes.

Treatment	g/kg DM	mg kg⁻¹ DM⁺		
	P	Cu	Zn	Fe
Litter -N	2.48a	11.5a*	44.6a	239.1a
Litter-P	2.14b	10.1b	39.4a	194.8b
Litter P+N	2.19b	10.4ab	44.0a	187.2b
INORG	2.24ab	10.3ab	41.0a	201.8ab

* Numbers followed by the same letters within a row do not differ at the 0.05 level of significance.

+Dry Matter

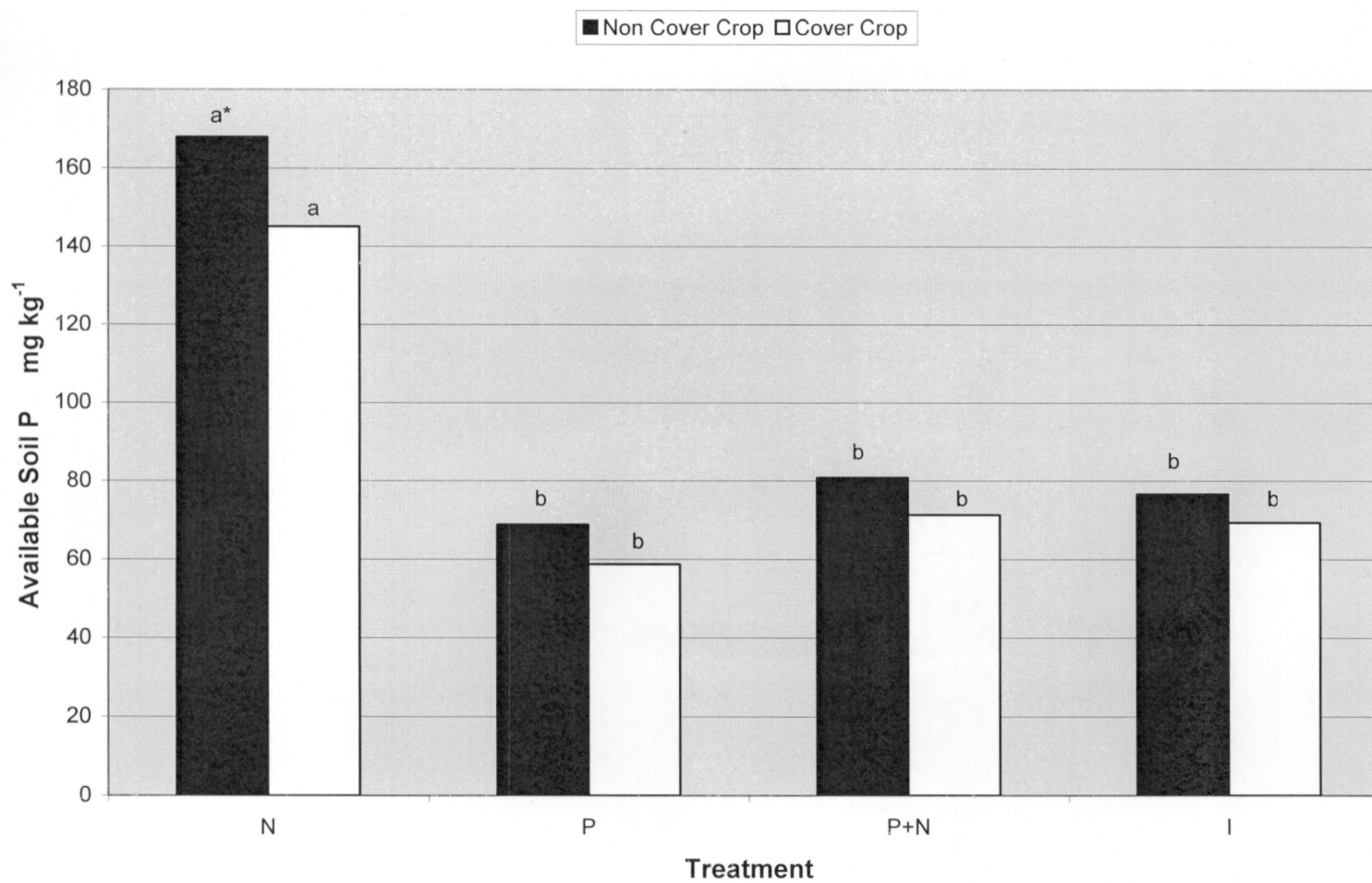


Figure 1. Available soil P as influenced by treatment and presence or absence of a rye cover crop.

*** Means followed by the same letters within treatment do not differ at the 0.05 level of significance.**

Soil available K did show significant difference between treatments as well as between cover crop regimes. All treatments showed differences between the amount of nutrients left in the soil without the cover crop and amount left with the cover crop. On average the cover crop removed 40% more K from the soil than did plots without a cover crop (Figure 2).

Soil available Ca showed no variation statistically between either the treatments or the cover crop use. Again it is evident that more nutrients remained in the soil in plots without a cover crop, but not to a statistically significant level (Figure 3).

A rye cover crop did not reduce available soil Mg or S. When no cover crop was present, plots receiving a high rate of litter (Litter-N) contained more available Mg and S than did plots receiving inorganic fertilizer. The cover crop removed an average of 30% more Mg and 10% more S from the soil than did the plots without a cover crop (Figure 4, Figure 5).

Table 5 illustrates the soil available micronutrient concentrations. A rye cover crop did not influence available soil Cu, Fe, Mn, and Zn. Use of a cover crop on Litter-N plots removed nearly double the Na as compared to the non cover crop plots.

When considering the previous data it can be determined that another factor may better indicate whether the use of a cover crop removes more nutrients from the soil. Table 6 illustrates forage yield of the rye cover crop under the varying fertility regimes. Litter-N rates produced the greatest yield, while Litter-P+N and INORG treatments produced yields comparable to each another. Litter-P yield, although not statistically lower, produced a yield nearly 1,000 kg DM ha⁻¹ less than the Litter-P+N and INORG plots.

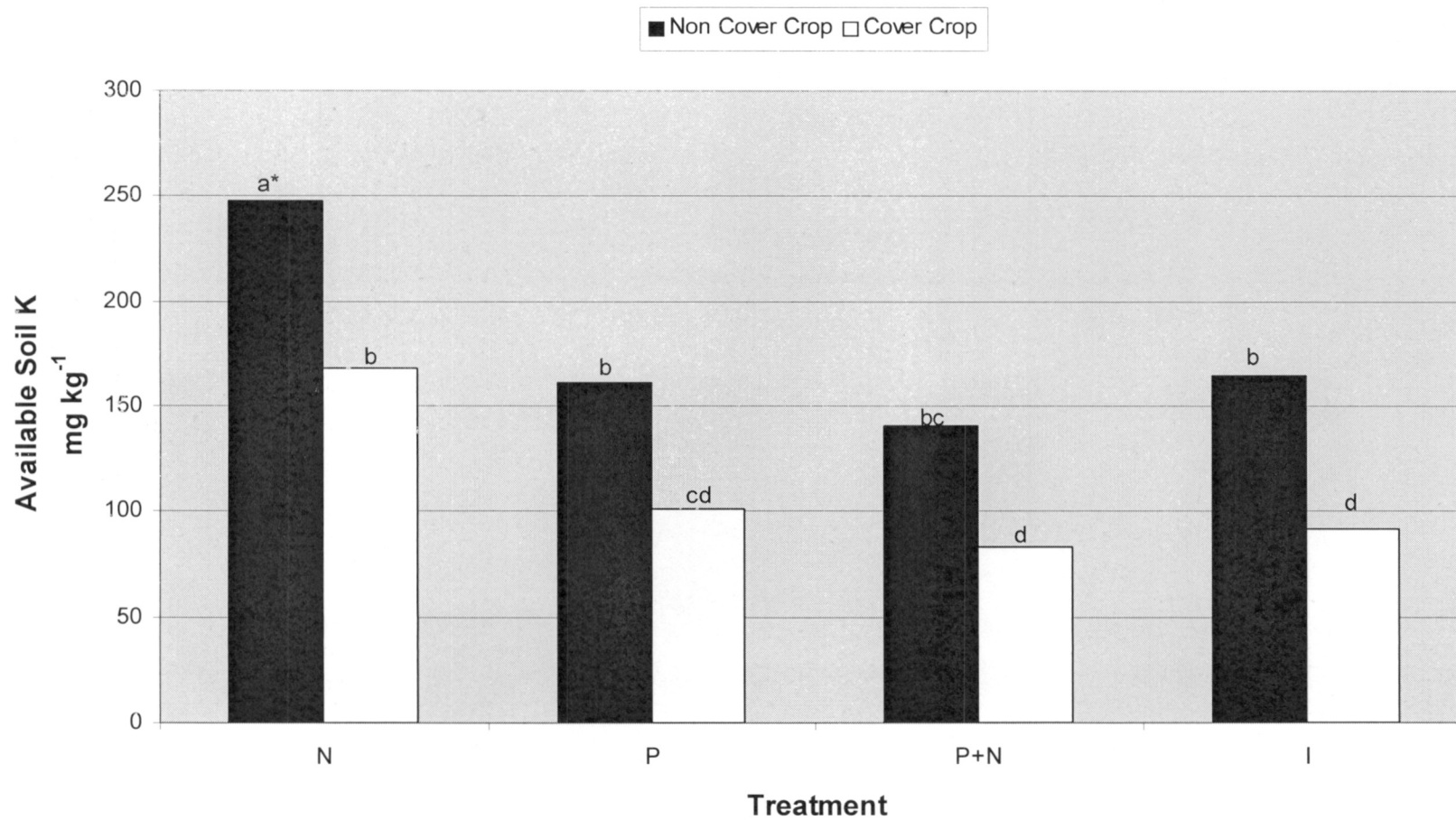


Figure 2. Available soil K as influenced by treatment and presence or absence of a rye cover crop.

*** Means followed by the same letters within treatment do not differ at the 0.05 level of significance.**

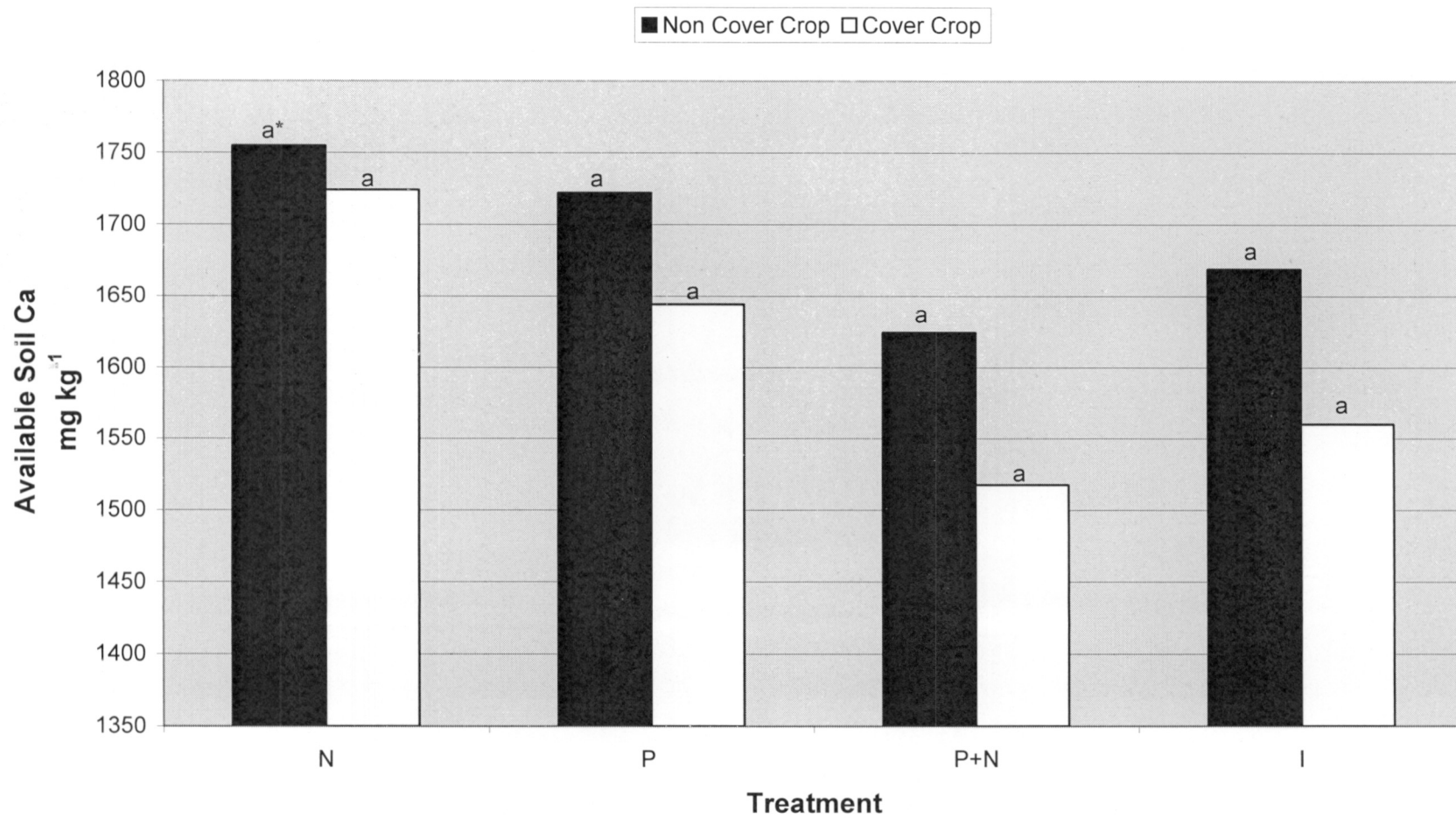


Figure 3. Available soil Ca as influenced by treatment and presence or absence of a rye cover crop.

* Means followed by the same letters within treatment do not differ at the 0.05 level of significance.

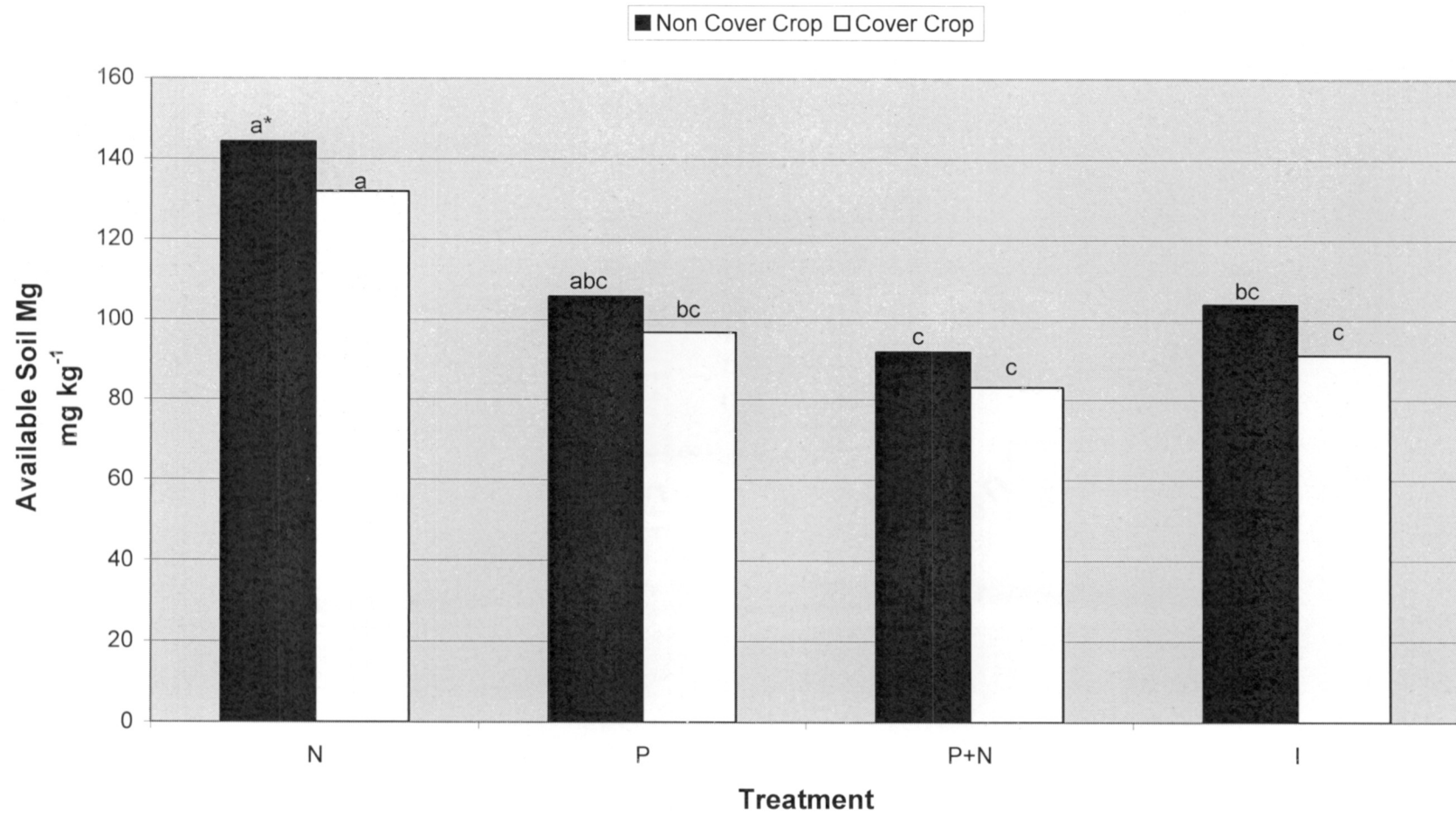


Figure 4. Available soil Mg as influenced by treatment and presence or absence of a rye cover crop.

* Means followed by the same letters within treatment do not differ at the 0.05 level of significance.

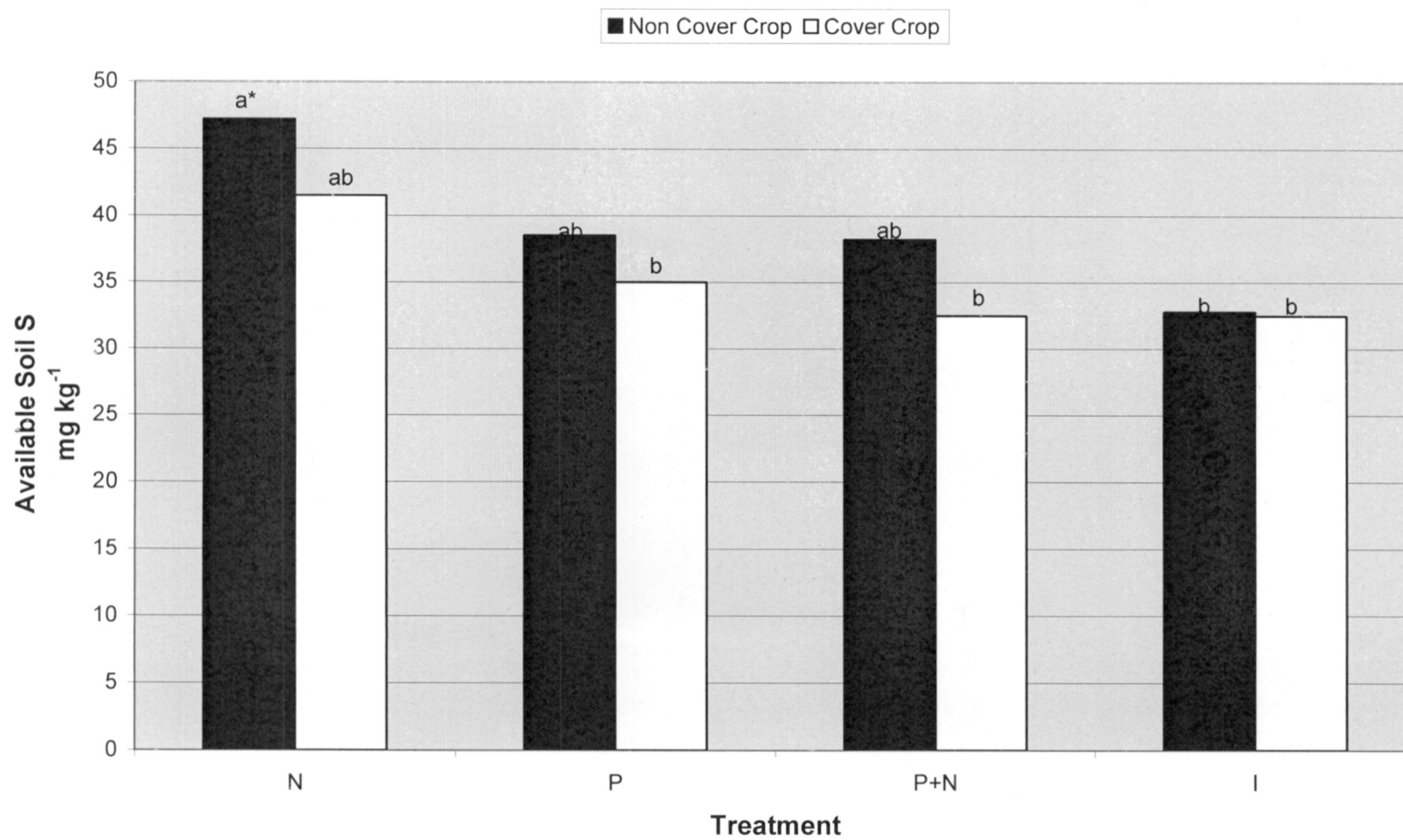


Figure 5. Available soil S as influenced by treatment and presence or absence of a rye cover crop.

* Means followed by the same letters within treatment do not differ at the 0.05 level of significance.

Table 5. Soil available micronutrient concentrations as influenced by treatment and presence or absence of a rye cover crop.

-----mg kg ⁻¹ -----												
Treatment	B		Cu		Fe		Mn		Na		Zn	
	<u>CC</u>	<u>NCC</u>	<u>CC</u>	<u>NCC</u>	<u>CC</u>	<u>NCC</u>	<u>CC</u>	<u>NCC</u>	<u>CC</u>	<u>NCC</u>	<u>CC</u>	<u>NCC</u>
Litter-N	1.55a	1.32abc*	4.66a	5.12a	145.7a	168.1a	178.0a	197.6a	32.8b	64.0a	8.00a	7.47a
Litter-P	1.50ab	1.26c	2.58b	2.67b	130.2a	140.1a	156.1a	169.0a	24.7c	23.5c	4.04b	3.62b
Litter-P+N	1.40abc	1.20c	2.70b	2.98b	142.0a	153.8a	168.1a	188.6a	24.5c	25.0c	4.63b	3.93b
INORG	1.40abc	1.32bc	2.59b	2.58b	133.9a	147.1a	153.8a	174.0a	23.3c	26.3c	3.99b	3.87b

*Numbers followed by the same letters within a nutrient do not differ at the 0.05 level of significance.

CC - Cover crop

NCC - No cover crop

Table 6. Forage yield of rye cover crop as influenced by treatment.

Treatment	---kg DM ⁺ ha ⁻¹ ---
Litter-N	5504a*
Litter-P	1548b
Litter-P+N	2595b
INORG	2230b

*Means followed by the same letters within a column do not differ at the 0.05 level of significance.

+ Dry Matter

Litter-N plots had on average higher ADF, NDF, and nutrient uptake abilities as well as more nutrients removed by cover crop from the soil when compared to Litter-P treatments. One potential reason for this could be that when applying broiler litter based on N needs, there becomes an overabundance of P and other nutrients available to both the plant and soil. When these extra nutrients are applied and are not taken up by the forage they then remain in the soil and allow for nutrient build-up to occur. Soil analysis indicated that a greater percent of nutrients were removed by cover crop in the Litter-N plots than in Litter-P plots, but more nutrients remained in Litter-N plots. Therefore when applying broiler litter based on Litter-N requirements rye yield was maximized but soil available P, K, Ca, Mg, and S were somewhat higher.

When considering soil nutrient availability as well as the above Litter-N information, it is obvious why soil P, although not statistically significant throughout, is much greater at the Litter-N fertility regime than the others. When litter is applied at rates sufficient to satisfy plant N requirements, P is often supplied in excess of plant P needs. Although most nutrients were not found to be statistically significant, the tested nutrients showed evidence of differences between the plots containing a cover crop and plots without a cover crop. In most situations it was evident that the cover crop did remove some of the nutrients from the soil that would have otherwise been left behind. From this it can be determined that while statistically speaking there were not enough differences found to prove that these results would in fact occur annually, it can be stated that the cover crop did remove soil nutrients.

Soil available K levels contrasted with results from the rest of the study. Data indicates that the cover crop did in fact remove a large amount of K from the soil versus

the non cover crop plots. A 2002 study of nutrient uptake and poultry litter determined that the majority of nutrients taken up by rye are in the stems and leaves, and sometimes even held in the flowers. Potassium concentrations over the two-year study were consistently greater in the plant stems, leaves, and flowers than in the roots (10). Therefore by harvesting and removing the rye cover crop from the location, there was a considerable amount of K removed from the soil in the plants stems, leaves, and flowers.

CHAPTER V

SUMMARY

The objectives of this research were to assess total nutrient removal by sorghum sudangrass followed by a rye cover crop compared to single crop of sorghum sudangrass as a tool for preventing excessive soil nutrient accumulation.

Field studies indicated that the use of a rye cover crop did not affect soil nutrient concentrations for most of the nutrients tested. However the data did show evidence that a greater percent of nutrients remained in the soil from plots without cover crops versus those with cover crops.

After assessing the broiler litter effects on rye at different fertility regimes it can be determined that the Litter-N results were the most positive from a producers aspect. However, the data indicated that although Litter-N plots produced the highest yield and overall the most nutrient removal when compared to Litter-P plots, Litter-N plots were still detrimental to the overall issue of soil nutrient accumulation.

When applying litter based on plant P requirements and adding supplemental N, the results indicate that this fertility regime is most closely related to that of applying inorganic fertilizer. From a producers aspect, applying Litter-P+N would be the most effective in creating results similar to applying inorganic fertilizer. Therefore the producer has the ability to replace the high cost of inorganic fertilizer with broiler litter and supplement N and still maintain the desired results they would have otherwise obtained using inorganic fertilizer.

With the exception of soil available K, a rye cover crop did not reduce available soil nutrients within a given treatment. The rye cover crop did in fact remove a greater percentage of soil nutrients, thus alleviating some of the build-up effects. Removal of soil nutrients is directly based on removable yield. If a producer using broiler litter fertilizer on their forage crop wants to alleviate some of the nutrient build-up then it must be understood that nutrient removal can only occur by completely moving the nutrient containing entity from the area. Whether in the form of hay, haylage, silage, or through a grazing system, producers must realize that leaving the forage or animals in the area will not remove the nutrients but rather redeposit them.

Therefore it cannot be stated that applying a rye cover crop to broiler litter amended soils for one year will in fact significantly remove soil nutrients. It can however be determined that the rye cover crop did remove nutrients from the plot area, just not to a significant level. This indicates that further study needs to be conducted to assess the influence of a rye cover crop upon mitigation of excessive soil nutrient concentrations.

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